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Higher Education

Features for DECEMBER 1961

Higher Education and the Atomic Energy Commission

GLENN T. SEABORG

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Office of Education

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Higher Education and the Atomic Energy Commission

By GLENN T. SEABORG*

CAPACITY for intellectual achievement is a national resource of first magnitude. If this thesis is sound, it behooves *all* parts of the national community to cultivate and nurture scholarly accomplishment. The society in which we live has a need for intellectual development far beyond its present sights—not just in the narrow sense of preparation for national survival, but in the broader sense of social and cultural survival. Our society has developed the capability to produce all the tangible essentials of a "good" life, but its excess capacity for material production floods it with superficialities. The people of a consequential society must have access to more significant matters on which to spend their wealth and leisure than inconsequential refinements and catchy gadgets. Whatever may be the eventual results of intellectual pursuits, whether they be greater material benefits or more profound satisfaction for the mind and spirit, dynamic social development calls for more scholars and more scholarship in higher education. I believe that the *national* community must accept a major share of the responsibility for supporting, strengthening, and expanding graduate education and basic research in *all* intellectual pursuits.

In this article, however, I propose to restrict the discussion fairly closely to the growing importance of *scientific* research and graduate education for the national security and welfare, and to maintain that Federal support for these activities in the sciences

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*Chairman of the Atomic Energy Commission since March 1, 1961. Prior to his acceptance of the chairmanship, Dr. Seaborg served as Chancellor of the University of California at Berkeley for 2½ years.

Dr. Seaborg received the bachelor of arts degree in chemistry from the University of California at Los Angeles in 1934 and the doctor of philosophy in chemistry from the University of California at Berkeley in 1937.

From 1937 to 1942 he was in the Department of Chemistry at the University of California at Berkeley as research associate, instructor, and assistant professor. In April 1942, Dr Seaborg was given a leave of absence to head the plutonium work of the Manhattan Project at the University of Chicago Metallurgical Laboratory. He remained at the Laboratory until May 1946 as chief of the section working on transuranium elements.

In 1945, while still on leave from the University of California, Dr. Seaborg was made full professor of chemistry. In May 1946 he returned to his department at the University and also took responsibility for direction of nuclear chemical research at the Lawrence Radiation Laboratory, which the University operates for the Atomic Energy Commission. In 1954 he was named Associate Director of the Laboratory, a position which he resigned upon coming to the Commission.

In 1940, Dr. Seaborg was a co-discoverer of element 94 (plutonium), the first of a number of transuranium elements which he helped discover in subsequent years. In addition to the discovery of transuranium elements, Dr. Seaborg and his colleagues are responsible for the identification of more than 100 isotopes of elements throughout the periodic table. He is the author of approximately 200 scientific papers, including a number of comprehensive reviews and compilations in scientific publications, and author and co-author of several books on chemistry and the elements.

Dr. Seaborg has received many scientific awards including the American Chemical Society's award in pure chemistry in 1947, and the Atomic Energy Commission's Enrico Fermi Award in 1959. With E. M. McMillan, of the University of California, Dr. Seaborg was awarded the Nobel Prize in Chemistry in 1951.

Dr Seaborg was appointed by President Truman in 1946 to be a member of the AEC's first General Advisory Committee, a post he held until 1950. He was a member of the Joint Commission on Radioactivity of the International Council of Scientific Unions from 1946 to 1956, of the Committee on Standards and Units of Radioactivity of the National Research Council from 1947 to 1951, and of the President's Science Advisory Committee from 1959 to 1961.

should continue on an increasing scale, wherever excellence now exists and wherever it shows promise of developing. Within the existing structure of Federal support, the Atomic Energy Commission possesses, and has a good record of utilizing, its opportunities for promoting scientific research over long periods and for achieving broad objectives in higher education in the sciences. For the future, I believe the Government must further strengthen its policies for the support of basic research and graduate education in the universities.

The Atomic Energy Commission has an innate and very vital concern with higher education and the further pursuit of knowledge. During the past decade and a half, the Commission has expressed its interest through its support of programs of basic research in academic institutions, through direct assistance to schools and to their faculties and students, and through its designation of universities and university associations as the appropriate contractors to operate most of the major AEC laboratories.

Knowledge, Research, and Atomic Energy

The atomic energy program was initiated and developed for its possible contributions to *military power*. The program was further developed, as peacetime applications were pursued, for its possible contributions to *electric power*. As a third component of its possible contributions, the *knowledge* generated by atomic energy may become a more powerful influence in human affairs than its contributions to either military or electric power. This pursuit of fundamental scientific knowledge, as the third and integral component of the atomic energy program, is made possible by the provision of great new tools—machines, methods, techniques, concepts, and incentives—for much more profound research into the physical and life sciences, not at all forgetting their potential in the psychological and social sciences.

That scientific research and pursuit of knowledge are integral components of the total atomic energy program was made clear by the words of Congress in its 1954 version of the Atomic Energy Act (Section 31.a.),[1] which stated that the program should be conducted not only for national security and developmental programs, but also for its contributions to "an ever-expanding fund of theoretical and practical knowledge."

These words set the stage for the interest and subsequent involvement of the Atomic Energy Commission in higher education—that is, in the teaching and research activities of the academic community. Our universities have been, and will continue to be, part of the foundation upon which our Nation's atomic energy program is built. The Atomic Energy Commission has been dependent on the universities from the beginning. Participation by the universities in its programs has made it possible for the Commission and the Nation to obtain urgently needed expansion of new knowledge and, simultaneously, to cultivate the production of additional scientific and technically trained manpower.

The Commission's dependence on the universities, however, is only a part of the total situation. The Federal Government as a whole is deeply involved. The National Science Foundation reports[2] that in the fiscal year 1961 this country expended $5 billion for basic and applied research, of which $0.9 billion went to colleges and universities for basic research.[3] Two-thirds of the universities' expenditures for basic research—$600 million—came from Federal funds through allocation by the Federal agencies according to their authority and requirements. Some 21 percent of these millions came from the Atomic Energy Commission—that is, the AEC "purchased" by contract 128 millions of dollars' worth of needed basic research from the country's academic community! These figures, which are reported by Government agencies to show the amount of basic research supported by the Government, depend to a great extent, however, upon the strictness with which each agency interprets the definition. A fair estimate is that nearly a fourth of the Commission's $863 million research and development budget (exclusive of construction costs), or some $200 million, went to support research of a broadly basic nature in fiscal year 1961.

To say that the Atomic Energy Commission purchased "needed" basic research from the universities may sound something like a contradiction in terms. How can AEC have *need* for results which by defi-

[1] Atomic Energy Act of 1954, Public Law 703, 83d Cong., ch. 1073—2d session, H.R. 9757.

[2] "Investing in Scientific Progress," NSF Report 61-27.

[3] "Basic research" is defined as research designed primarily to develop new knowledge and understanding, whether immediately applicable or not. "Applied research" and "exploratory developments" may be defined as the first efforts to convert scientific information into technology, while "development" is the calculated effort to design and build something new and useful. —"Strengthening American Science," a report of the President's Science Advisory Committee.

nition are not necessarily useful? The answer is reasonably obvious if one thinks about it briefly. The mission of the AEC is clearly defined in its Act, that "the development, use, and control of atomic energy shall be directed . . ., subject at all times to the paramount objective of making the maximum contribution to the common defense and security . . . so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise." [4]

Programs to attain these major objectives break down into smaller packages, each with its own specific limited objective. Thus, to make more readily available to us the energy which is known to reside in the nuclei of matter, the Commission needs to know all it can about the constitution of matter and how fundamental particles interact with matter—hence it supports a broad program of research in basic nuclear physics, each project with its own limited objective. Each objective may require "pure" basic research and display no evident applicability to anything, but as has been so aptly stated:

"The most impractical thing that can be done in designing and directing programs of research is to worry overmuch about how 'practical' they are. The secrets and treasures of Nature are written in the most obscure and unexpected places. It is clear, therefore, that the strongest scientific program is the program with the greatest breadth and scope. It is impossible to predict from which quarter the next scientific advance will come; but we can try to make sure that the Nation has able people at work across the whole scientific frontier." [5]

This principle holds true in the life sciences as well as in the physical sciences. The Commission is charged with the protection of living things against the detrimental effects of the byproduct radiation which is produced in the development of atomic energy. It also seeks to find diagnostic, therapeutic, and other beneficial uses for the biological effects of the radiations and radioactive materials which it produces. These are very specifically applied objectives from the point of view of the Commission, but the component projects for which the Commission writes contracts with the universities range from the study of absorption of radiation by molecules to the study of the effects of radiation on broad ecological systems. From the point of view of the investigator, some of these studies may be of the most basic kind, pursued by him purely for their contributions to scientific knowledge and understanding. From the point of view of the Commission, however, each project plays its own inimitable part and contributes its own bit toward fulfillment of the basic mission of the AEC. So it can be said that AEC *must* purchase basic research to meet its needs, and such research is "pure" or "applied" depending upon the point of view and the application of definitions. At the same time, the amount of dollar support for "pure" as contrasted to "applied" research is also indeterminate.

Hence the AEC has been involved, and fruitfully so, in the support of pure or basic research in American universities, and in some foreign ones, ever since its inception. In some cases, the Commission has directly solicited the services of university groups who possessed the needed specialties and aptitudes. In most cases, however, it entertains or indirectly solicits proposals from investigators who want financial help for the utilization of their available ideas, time, and services. Usually, in such cases, the investigator wants to do the work, and AEC wants the work done. Under circumstances such as these, both sides are winners!

The AEC has used the fixed-price lump-sum "contract" rather than the "grant" system for its support of university research. This type of research support system was adopted with the belief that it was most suitable for carrying out the AEC's assigned mission. The lump-sum contract as administered by AEC extends flexible terms to the investigator and is not generally subject to any more restrictions than is the grant as presently administered by other Federal agencies. As used by AEC, the contract can provide assurance of support for 3 to 5 years through a "letter of intent." Such continued support is of course contingent on the availability of funds to the agency. The AEC does not attempt to direct specific research projects, although it may be highly selective of what projects it supports. Once a proposal is accepted for support, the work can progress in the best sense of free pursuit of scientific knowledge. The general question as to the best system for research support is under review in order to try to establish means for further improvements.

[4] Atomic Energy Act of 1954, Public Law 703, 83d Cong.

[5] "Strengthening American Science," A Report of the President's Science Advisory Committee, 1958.

Higher Education and Atomic Energy

Thus far I have written only of the Government's and AEC's interest in *research* in the academic field. This article is intended to discuss their interest in higher education. The link between basic research and graduate education has been propounded at length in a recent report [6] which maintains that the process of graduate education and the process of basic research belong together, and that the two kinds of activity reinforce each other. "The apprentice scientist learns best when he learns in an atmosphere of active research work."

Research supported by the Federal agencies helps to provide that atmosphere. It helps to provide the professor or department with funds and equipment to carry out basic investigations in keeping with the interest and competence of the principal investigators. It helps the graduate student himself to take an active part in the research because the participation of graduate students as research assistants is encouraged whenever possible and practical—more often than not on a paid part-time basis. The graduate student learns by *doing* science, and his participation in a project is his most important step toward becoming a scientist.

It is not my intent to belabor this point further. I shall simply assume the validity of the Science Advisory Committee's thesis (statement 1960) that future scientists will come primarily from schools where the spirit of scientific inquiry prevails. AEC research programs encourage that spirit and hence encourage the production and development of new scientists in the best tradition.

In the broader intellectual development which I believe is so important to the well-being of our country, science and scientists will play a major role. That role may eventually become considerably greater than at present, but in the immediately foreseeable future there is no doubt as to its importance. Federal agencies and all research institutions will need more scientists to carry out the projected research programs of the country in the next few years than appear to be forthcoming. In the AEC, projection of the life-science program calls for the research time of something like an additional thousand scientists in the next 5 years. The programs of the physical sciences and nuclear engineering are based on the services of several thousand more scientists than are presently in action.

Herein lies the Nation's concern with higher education. Imagination and independence of thought are needed to point the way to more fruitful uses of national resources and nuclear energy. Scientists are needed to attain these national goals. Fulfillment of these needs is a mutual responsibility of the universities and the Government, but in the fulfillment the universities have also a responsibility to insure that their growing partnership with the Government shall reinforce their freedom and excellence and shall not subvert them to wholly mundane objectives.

Educational Programs of the AEC

In this article, it has been my intent to set forth, as I see them, the relationships of the university community with the Federal Government—the needs which each has and the mutual assistance which each can give the other. More specifically, I shall attempt to describe the part that the Atomic Energy Commission plays in this mutual relationship.

The AEC is one of the Federal agencies which has been and will continue to be highly dependent upon the university system for research services, for its laboratory manpower, and indeed for its acceptance by the public as a legitimate enterprise. It must have an increasing number of scientists to attain its own individual goals. To help fulfill these needs, it maintains programs for catching and stimulating the interests of potential science students as far down as the high school level; it supports programs for assisting their education in science at the college level and graduate level, and looks toward doing more; it provides many opportunities for research at the postdoctoral level, which is in effect the most powerful incentive it can give to capable students as they plan their careers.

In addition to the broad objective of rendering assistance to the university community in all practical ways, the Commission has three very specific self-interest objectives in conducting its educational programs:

(1) To insure an adequate supply of capable engineers and scientists well versed in the properties and potential uses of nuclear and radiation materials and tools; this process of assurance

(*Continued on page 19*)

[6] "Scientific Progress, the Universities, and the Federal Government," Statement by the President's Science Advisory Committee, 1960. (See also "Higher Education," December 1960.)

Higher Education in the 87th Congress

By CHARLES W. RADCLIFFE*

IN his Message to the Congress of February 20, 1961, relative to American Education, President Kennedy stated,

Our progress as a nation can be no swifter than our progress in education. Our requirements for world leadership, our hopes for economic growth, and the demands of citizenship itself in an era such as this all require the maximum development of every young American's capacity.

The human mind is our fundamental resource. A balanced Federal program must go well beyond incentives for investment in plant and equipment. It must include equally determined measures to invest in human beings—both in their basic education and training and in their more advanced preparation for professional work. Without such measures, the Federal Government will not be carrying out its responsibilities for expanding the base of our economic and military strength.

The President went on to state, as a preface to his remarks on the needs of higher education, "Our colleges and universities represent our ultimate educational resource." This Message contained three major recommendations for strengthening that resource. These were:

> (1) Extend the current college housing loan program with a 5-year $250 million a year program designed to meet the Federal Government's appropriate share of residential housing for students and faculty. As a start, additional lending authority is necessary to speed action during fiscal 1961 on approvable loan applications already at hand.
>
> (2) Establish a new, though similar, long-term, low-interest-rate loan program for academic facilities, authorizing $300 million in loans each year for 5 years to assist in the construction of classrooms, laboratories, libraries, and related structures—sufficient to enable public and private higher institutions to accommodate the expanding enrollments they anticipate over the next 5 years; and also to assist in the renovation, rehabilitation, and modernization of such facilities.
>
> (3) Establish a 5-year program with an initial authorization of $26,250,000 of State-administered scholarships for talented and needy young people which will supplement but not supplant those programs of financial assistance to students which are now in operation.

The first of these proposals is now embodied in Title IV of the Housing Act of 1961 (Public Law 87–70), which authorizes college housing loans of $300 million for each of the 4 years beginning July 1, 1961.

The second and third proposals—assistance for the construction of academic facilities and scholarship aid—are contained in substance in two pending bills, S. 1241 and H.R. 7215. Each of these has been reported favorably by the committees in which they were considered (Senate Committee on Labor and Public Welfare; House Committee on Education and Labor). The House and Senate versions differ in some respects, both from one another and from the Administration proposal. This is often the case with respect to major legislation which is considered independently in each House.

Very briefly, the two bills contain the following provisions:

S. 1241, reported on September 15, authorizes a 5-year program of (1) $1.5 billion in loans for the construction of college facilities, (2) $926 million for an estimated 212,500 4-year college scholarships, with accompanying cost-of-education grants to institutions, and (3) $250 million in grants for construction of public junior community colleges.

H.R. 7215, tabled in the Committee on Rules on July 18, authorizes a 5-year program of (1) $300 million for an estimated 200,000 2-year college scholarships, and (2) $900 million in grants and $600

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million in loans for the construction of college facilities.

Despite the tabling of the House bill by the Committee on Rules, it is fair to say that the legislation is very far along the road to enactment by the 87th Congress. Many imponderables are involved in an attempt to forecast congressional action. but it would appear that the chances are very good that this legislation will be enacted during the second session, which convenes on January 10, 1962.

During the first session of this Congress a great deal of work was done on other legislative proposals of interest to higher education. For example, in both Houses committees reported bills that would extensively amend and expand the National Defense Education Act (S. 2345 and H.R. 7904). However, the act was extended for 2 years beyond June 30, 1962 (without amendment) by P.L. 87–344. The essential immediate objective of providing for continuation beyond 1962 of such vital programs as student loans and National Defense Fellowships has been attained.

This is a fragmentary report. Any complete summary of enacted or pending legislation of interest to higher education would include a discussion of the "Mutal Educational and Cultural Exchange Act" (P.L. 87–256), which in effect places in one act the several programs of international educational and cultural exhange; the "Act for International Development" (P.L. 87–195), which contains vitally important authorization for educational and human resources development in less developed nations; assistance for the development of educational television (S. 205, H.R. 132); and pending proposals for the construction of medical, dental, osteopathic, and public health teaching facilities and for broad scholarship assistance in these fields (S. 1072, H.R. 4999). These and other measures will be the subject of later reports in *Higher Education*.

The prospects are that this Congress, when its work is completed in 1962, will have authorized substantial new programs in a number of fields of interest, designed to strengthen the ability of higher education to serve the basic interests of our society.

Soviet Interpretation of U.S. Higher Education

By SEYMOUR M. ROSEN*

THE MOST IMPORTANT Soviet educational publication to be released recently is a statistical handbook on higher education in the USSR, *Vysshee Obrazovanie v SSSR*. The handbook is an official release of the Soviet Government, published by the Central Statistical Administration attached to the USSR Council of Ministers. Soviet Minister of Higher Education Elyutin stated to me on September 29 in Moscow that *Vysshee Obrazovanie v SSSR* was being distributed to all the delegates (4,800 of them), including all the foreign delegates, to the Twenty-Second Congress of the Communist Party of the Soviet Union, held in Moscow October 17–31. It may be assumed that a fair proportion of the delegates to the Congress from 80 foreign countries would return to those countries with the handbook and that the section of the book devoted to international education statistics would receive particular attention and dissemination.

The picture of the U.S. higher education which emerges from this Soviet handbook should receive the serious attention of U.S. educators. Unfortunately, from this mosaic of selected data and generalizations, readers unfamiliar with U.S. educational

*Specialist in Comparative Education for Eastern Europe, Division of International Education. In the past year Mr. Rosen has travelled to the Soviet Union twice for the Office of Education. In September he accompanied a delegation of seven U.S. Congressmen, all members of the Special Subcommittee on Education of the House Committee on Education and Labor, in a field study of the Soviet system of higher education.

Mr. Rosen holds an A.B. degree from Brown University and an M.A. degree and the Certificate of the Russian Institute from Columbia University. For the past 8 years he has served as a Government specialist in Soviet and Eastern European affairs.

practice can be expected to receive an inaccurate impression of our colleges and universities.

The first table of the international education section in *Vysshee Obrazovanie v SSSR* (pages 249–251) lists recent annual enrollments of students in higher educational institutions by country. The USSR is listed first, followed by 12 Communist countries and 45 non-Communist countries of Europe, Asia, Africa, and America.

The USSR is listed for the school year 1960–61 as having a population of 216,147,800, a student enrollment in higher educational institutions of 2,395,500, and a ratio of 111 students in higher education per 10,000 population.

The statistics given indicate that the USSR is far ahead of all 57 other countries listed except the United States, not only in higher education enrollment totals but in the ratio of students to the total population. Excluding the United States, the Soviet Union ratio of 111 per 10,000 population compares with 70 in the next highest country on the list, Bulgaria. The Soviet ratio compares with a ratio of 59 in Japan, the highest in a non-Communist country, and 45 in Finland, the highest in non-Communist Europe.

The United States is the only country which receives special treatment in the comparative table in that two sets of data on the United States are presented. First, data "according to published official American statistics" on the United States for the 1959–60 school year are given: population—177,702,000; student enrollment—3,377,300; ratio of students per 10,000 population—190. The ratio, one notes, is considerably higher than the USSR ratio of 111. Second, data are given on United States enrollments in higher education, with the parenthetical statement that excluded are enrollments in junior colleges, enrollments in the first two years of other colleges and universities, and enrollments of doctoral candidates. The number of students enrolled in higher education in the United States is listed as 1,816,400 and the ratio as 102 per 10,000 population. The United States is thus depicted as having a lower enrollment in higher education than the USSR and a lower ratio of enrollments to total population.[1]

[1] EDITOR'S NOTE: U.S. statistics for the 1960–61 school year are: population—181,519,000; opening fall student enrollment (degree-credit)—3,610,000; ratio of students per 10,000 population—199.)

The next page of *Vysshee Obrazovanie v SSSR*, following the listing of statistics for the United States, is devoted to statements used to support the argument that the first 2 years of higher education in the United States are equivalent only to secondary education. In effect this would equate 14 years of American education (12 primary-secondary plus 2 higher) with 10 or 11 years of Soviet primary-secondary education. On this basis the Soviet handbook argues that enrollment figures on American higher education should exclude students in the first 2 years of college. In a volume which contains hundreds of tables of statistics the only page of text, aside from the introduction, is the following:

> Data for the USA published by American official statistics include students of junior colleges, which are not higher educational institutions, and students in the first 2 years of other colleges and higher educational institutions, which in level of training are regarded as the senior classes of secondary school.
>
> In the prewar period, in the introduction to the section "Higher Education" of a biennial survey of public education in the USA (published in 1935), American official statistics noted: "Frequently a comparison is made (of the number of students in universities and colleges of the USA) with the number of students in higher educational institutions of European countries. Such a comparison is usually highly erroneous. In the majority of European countries, prior to admission to a higher educational institution students complete a course of study equivalent to the first year of our college, and in many instances to the second year of our college.
>
> "If data are compared on the number of students in European countries with the number of students in the senior half in universities and colleges in the USA, and normal school students are excluded, then our student enrollment, still remaining more than double that of European countries, is not as fantastic as it is usually considered."
>
> In the book of Professor [Chris] De Young, *Introduction to American Public Education*, published in New York in 1955 (page 192), it is noted: "Traditionally a junior college has been defined as an institution of higher education, the 2-year program of which is equivalent to the program of the first 2 years of college. On the other hand, the conviction is growing that the junior college, as well as the first and second years of colleges and universities, belongs to the secondary school level."
>
> In the directory *American Universities and Colleges*, published in 1960 by the American Council on Education, it is explained that "In America the period of general education extends two years beyond the conventional high school course, to the middle of the 4-year undergraduate course in the standard college or university. At the end of his second year in college the American student is at a point approximately analogous to

that at which the French or German student completes secondary school (lycée or gymnasium)."[2]

In the English journal *Research Problems of Labor* for September 1956 (p. 134), it is indicated that the program of study for the first 2 years of American colleges and analogous higher educational institutions is approximately equal to the program of the last six classes of the secondary general education schools in England.

Taking this into account, from the published American official statistics on student enrollments in universities, colleges, and analogous education institutions (3,377,300) the USSR Central Statistical Administration has excluded students of junior colleges (409,000), students of the first two years of other colleges, universities, and similar educational institutions (1,115,000), and also doctoral candidates (37,000).

Official American statistics on higher education enrollments include students in universities, colleges, professional schools, junior colleges, and teachers colleges. Programs in such institutions are based on completion of the 12-year cycle of elementary-secondary education.

U.S. Office of Education statistics on degree-credit enrollments in institutions of higher education in the United States during the first semester or quarter of 1959–60 total 3,470,800, excluding enrollments in correspondence courses. In contrast, of the 2,395,500 students enrolled in Soviet higher educational institutions in 1960–61, 995,077—or 41.5 percent—were students by correspondence; that is, almost half of the students currently enrolled in Soviet higher education are enrolled in and will graduate from correspondence courses.

The student enrollment in USSR institutions of higher education in school year 1960–61 is shown below:

USSR population	216,147,800
Total enrollment	2,395,500
Enrollment excluding students in correspondence courses	1,400,500
Enrollment per 10,000 population:	
Including correspondence students	111
Excluding correspondence students	65

The ratio of students in higher education in the USSR excluding correspondence course students per 10,000 population remains high, equalling the figure given in the Soviet table for the Mongolian People's Republic.

Comparative data on engineers in the international section of *Vysshee Obrazovanie v SSSR* have appeared recurringly in other recent Soviet handbooks: In 1960, the USSR graduated 120,000 engineers and had a labor force of 1,116,000 engineers; the United States graduated 38,000 engineers and had 525,000 in the labor force. These data, which to be meaningful would require considerable elaboration, are presented in strict tabular form. No comparisons are made of the range of fields in which students in the two countries graduate and in which professionals are already employed in the two societies. Such comparisons would perhaps suggest differences in emphasis in two societies at different levels of development or at least be more workable for scholarly conclusions than isolated figures. The percentage of Soviet engineers who are products of correspondence courses is not given in Soviet statistics.

Vysshee Obrazovanie v SSSR devotes two pages of its introduction to criticism of the American system of higher education. Among the statements it makes are the following:

High tuition fees and scholarships for "only an insignificant number of American students" are reasons that higher education is inaccessible for the majority of workers and "the doors of higher education are even closed to middle-class American families."

Annual tuitions at Harvard, Columbia, and M.I.T. are "examples" of our higher education tuitions.

American farmer and worker families, not only cannot afford higher education tuitions, but they are "forced to send their children to work from the earliest age in order to support the precarious family budget."

"Equal rights to education for all American citizens is a myth." (To support this statement, the handbook cites a Harvard University commission report which indicates that a higher percentage of children of high-income parents receive a secondary and higher education than children of low-income parents.)

In a memorandum on education in September 1958, Premier Khrushchev stated:

We cannot overlook the fact that we still have few

[2] EDITOR'S NOTE: The words "secondary school" and the parentheses included in the last sentence of the quoted material from *American Universities and Colleges* (p. 6) do not appear in the original text. In that volume, the sentence reads: "At the end of his second year in college the American student is at a point approximately analogous to that at which the French or German student completes the *lycée* or *Gymnasium*.

> children of workers and collective farmers attending universities. In Moscow higher educational establishments, for instance, only 30 or 40 percent of the students are children of workers and collective farmers. The other students are children of employees [administrative officials and white-collar workers] or intelligentsia [professionals]. Of course, this is an obviously abnormal situation.

This statement poses the statistical problem of whether currently a higher percentage of the children of Soviet professionals and Communist Party and Government officials receive a higher education than the children of Soviet unskilled workers and collective farmers. This information might legitimately have been included in a handbook on Soviet higher education which treats of similar information on groups in the American system.

Office of Education Studies and Surveys

The Credit System

MANY COLLEGES and universities are questioning the accumulation of a specified number of classroom course credits as the only basis for granting the college degree. As a result, a growing number of institutions deviate from the strict interpretation of the semester hour to permit flexibility in class-hour credit requirements for students who come from diverse academic backgrounds. Some of the practices in use are independent study, credit by examination through which students demonstrate the required competence in certain courses, and comprehensive examinations designed to integrate the student's major areas and to provide over-all measures of proficiency.

The examination of candidates for admission to graduate study also indicates that many graduate schools prefer to apply their own measures of competence rather than to accept undergraduate evaluations which have traditionally been based largely on the accumulation of class-hour credits.

Current practices used to record and report student progress are analyzed in a new Office of Education report, *The Credit System in Colleges and Universities*, by Lanora G. Lewis, Programs Branch, Division of Higher Education.

Under the system still in vogue in some American colleges, the report points out, a student may be denied course credit if he misses more than a specified number of class periods, regardless of his proficiency. Moreover, in some colleges students may be required to take courses in which they already have the required competence from previous study or experience. In any given institution, then, the credit system must be assessed in terms of its relative adequacy in reporting levels of student competence.

Independent study courses, intended to restore flexibility in the rate, depth, or scope of study by individuals in a particular group, may have important implications for improvements in teaching-learning techniques, provided they are not limited by conformity to "equivalent formal class work."

Examination credits, to which many institutions have turned first in their search for flexibility in class-hour requirements, eliminate needless repetition for able students but do not necessarily lead to improvements in general teaching methods.

Comprehensive examinations encourage integration of course work, but standards have not yet been developed for using these for inter-institutional communication or as a substitute for other intermediate marks of progress.

The report concludes that, because the credit system affects the outlook of students, the development of programs, and the utilization of staff time and physical facilities, the cooperative development of improvements in the system for recording and reporting student progress may be an important factor in improving the very processes by which students become educated.

1961 Fall Enrollment

A NEW ALL-TIME HIGH of 3,891,000 degree-credit students (full time and part time) enrolled in the Nation's colleges and universities in the fall of 1961. This total exceeds the 3,610,000 fall enrollment of 1960 by 7.8 percent and represents a rise in opening fall enrollments for the tenth consecutive year. The data were obtained from the annual opening (fall) enrollment survey, conducted by the Educational

Statistics Branch of the Office of Education under the general direction of Justin C. Lewis.

The 1961 fall enrollees included 2,424,000 men and 1,467,000 women compared with 2,271,000 men and 1,339,000 women in the fall of 1960, a percentage increase of 6.8 for men and 9.5 for women.

The number of students enrolled for the first time in college rose to 1,026,000, a jump of 10.4 percent over the fall of 1960. Of the first-time enrollees this fall, 596,000 were men and 430,000 (41.9 percent) were women. In fall 1960, 543,000 new enrollees were men and 387,000 (41.6 percent) were women.

The survey includes both resident and extension degree-credit students—those whose current program consists principally or wholly of work leading toward a bachelor's degree or higher—studying full time or part time, either in the day or in the evening, at nearly 2,000 institutions of higher education listed in the U.S. Office of Education Directory, *Part 3*, and offering degree-credit programs. Included are universities, liberal arts colleges, teachers colleges, theological and religious institutions, other types of independently organized professional schools, and junior colleges.

Data from the annual survey were available this year several weeks earlier than last year as a result of the excellent cooperation of registrars and others in institutions of higher education who provided the information, and an earlier publication date was made possible by the introduction of mechanical procedures in the editing process.

The survey data are published in Circular 675, OE–54003–61 (see New Publications), showing part-time and full-time enrollments separately for each institution. This is the first year in which such data have been reported separately. Data by type of institution and a study of trends will be covered in a later issue of *Higher Education* and in subsequent analytic reports.

Earned Degrees Conferred 1959–60

FOR THE FIFTH consecutive year, the number of bachelor's and first-professional degrees conferred by institutions of higher education in the United States has increased. The approximately 395,000 such degrees conferred in the year ending June 30, 1960, represents an increase of almost 10,000 over the

Total and first-time opening (fall) degree-credit enrollment,[1] by sex: 1956–61

[Figures rounded to nearest thousand]

Year	Total degree-credit enrollment			First-time degree-credit enrollment [2]		
	Both sexes	Men	Women	Both sexes	Men	Women
	Number					
Fall 1961	3,891,000	2,424,000	1,467,000	1,026,000	596,000	430,000
Fall 1960	3,610,000	2,271,000	1,339,000	930,000	543,000	387,000
Fall 1959	3,402,000	2,174,000	1,228,000	827,000	491,000	336,000
Fall 1956	2,947,000	1,928,000	1,019,000	723,000	446,000	277,000
	Percent changes					
1960 to 1961 (one year)	+7.8	+6.8	+9.5	+10.4	+9.8	+11.2
1959 to 1961 (2 years)	+14.4	+11.5	+19.4	+24.1	+21.4	+27.9
1956 to 1961 (5 years)	+32.0	+25.7	+44.0	+41.9	+33.6	+55.3

[1] Degree-credit students are those whose programs consist wholly or principally of work normally creditable toward a bachelor's or a higher degree. Resident and extension degree-credit students, full time and part time, are included. Students taking degree-credit work at home by mail, radio, or TV, and all students in branches of U.S. institutions operated in foreign countries are excluded.

[2] A first-time degree-credit student is one who is reported as a degree-credit student but who has not previously been a degree-credit student in *any* institution of higher education. Students were reported as "first-time" in this survey if the fall of 1961 marked their first enrollment in any institution for programs of the degree-credit type.

preceding year, but a decrease of about 39,000 (9.0 percent) below the post-World War II peak.

The number of master's and doctor's degrees conferred during the year is the highest ever reported. The 74,500 master's degrees and the 9,800 doctorates represent increases of 7.2 percent and 5.0 percent, respectively, over the preceding year.

The proportion of degrees conferred on men and on women has remained about the same for several years. During 1959–60, approximately 2 out of 3 bachelor's and first-professional degrees, more than 2 out of 3 master's degrees, and 9 out of 10 doctorates were conferred on men.

With 90,200 bachelor's and 33,500 master's degrees, and 1,600 doctorates, the field of education accounted for nearly one-fourth (22.8 percent) of all bachelor's and first-professional degrees, almost one-half (45.0 percent) of all master's degrees, and a little over one-sixth (16.2 percent) of all doctorates.

Nearly one-fifth (18.7 percent) of all doctorates granted were in the physical sciences—a total of 1,800.

More than 4 out of 10 of the doctor's degrees were conferred in the combined scientific areas of the biological sciences, physical sciences, health professions, mathematics, and engineering. In contrast,

Earned degrees conferred, by major area of study, level of degree, and sex: Aggregate United States 1959–60

Major area of study	Bachelor's and first-professional			Second-level (master's, except first-professional)			Doctoral		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total	394,889	255,504	139,385	74,497	50,937	23,560	9,829	8,801	1,028
Agriculture	4,898	4,805	93	996	984	12	411	404	7
Architecture	1,801	1,744	57	319	305	14	17	17	0
Biological sciences	15,655	11,693	3,962	2,154	1,668	486	1,205	1,086	119
Business and commerce	51,522	47,629	3,893	4,643	4,476	167	135	133	2
Education	90,179	26,178	64,001	33,512	18,126	15,386	1,590	1,281	309
Engineering	37,808	37,663	145	7,159	7,133	26	786	783	3
English and journalism	22,456	9,001	13,455	3,192	1,670	1,522	405	321	84
Fine and applied arts	13,166	6,141	7,025	2,892	1,763	1,129	292	238	54
Foreign languages and literature	5,498	2,098	3,400	1,134	593	541	229	166	63
Forestry	1,437	1,437	0	207	206	1	29	29	0
Geography	973	858	115	206	177	29	68	64	4
Health professions	24,557	15,170	9,387	1,872	1,075	797	107	99	8
Home economics	4,450	60	4,390	484	11	473	40	6	34
Law	9,314	9,073	241	520	496	24	24	24	0
Library science	1,938	467	1,471	305	70	235	19	17	2
Mathematical subjects	11,437	8,312	3,125	1,765	1,428	337	303	285	18
Merchant marine—deck officer curriculum	202	202	0	0	0	0	0	0	0
Military, naval, or air force science	2,369	2,366	3	0	0	0	0	0	0
Philosophy	3,466	3,052	414	383	335	48	137	112	25
Physical sciences	16,057	14,041	2,016	3,387	3,060	327	1,838	1,776	62
Psychology	8,111	4,785	3,326	1,406	981	425	641	544	97
Religion	9,002	7,563	1,439	1,331	1,124	207	276	265	11
Social sciences	51,802	35,801	16,001	5,998	4,765	1,233	1,237	1,117	120
Trade and industrial training	1,548	1,537	11	0	0	0	0	0	0
Other broad general curriculums and miscellaneous fields	5,243	3,828	1,415	632	491	141	40	34	6

only 1 out of 4 of the bachelor's degrees and 1 out of 5 of the master's degrees were conferred in these areas.

These data were obtained from findings of the "Survey of Earned Degrees Granted During 1959–60," conducted by the Office of Education. A complete report and analysis, now in preparation by Wayne E. Tolliver, under the general direction of Justin C. Lewis, will include detailed data for 165 separate fields of study, analytic and historical material, and data by individual institution. The response to the survey represents 100 percent of the degree-granting institutions of higher education in the Nation. Data on earned degrees for 1960–61 are currently being received and validated.

Trends: Tuition and Fees, Room and Board

A RECENT Office of Education study reveals increases in average tuition and fee charges and in average charges for room and board in both public and private colleges and universities from 1957–58 to 1959–60. The data included in the trends study are based on reports from institutions which participated in the planning and management survey conducted by the Office of Education during each of the 3 years 1957–58, 1958–59, and 1959–60. Institutions that participated in the survey during only one or two of the 3 years were not included in the trends study.

Tuition and fees.—The average tuition and fee charges for undergraduate students in 329 public colleges and universities (including junior colleges) in 1959–60 were 7.9 percent higher than during the preceding year. The increase for the same institutions over a 2-year span (1957–58—1959–60) was 13.8 percent. The data were based on tuition and fees paid by almost 1.4 million undergraduate students in these institutions; for 1959–60 the average charges were $206.

The increase in average tuition and fee charges for undergraduate students in 497 private institutions (including junior colleges) from 1958–59 to 1959–60 was closely comparable to that in the 329 public institutions—7.6 percent, private; 7.9 percent, public. However, during the 2-year period 1957–58—1959–60, the increase in the private institutions was 19.5 in comparison with 13.8 in the public. Data for the private colleges and universities were based on tuition and fees paid by almost 0.9 million undergraduate students; for 1959–60 the average charges were $833.

Room charges.—Average institutional dormitory charges in 197 public 4-year colleges and universities showed an increase of 6 percent fron 1958–59 to 1959–60 and an increase of 11.5 percent over the 2-year period 1957–58—1959–60. In 321 4-year private colleges and universities, the average institutional dormitory charges increased 6.1 percent during the same 1-year period and 12.5 during the 2-year period. The average institutional dormitory charges in 1959–60 were $174 in the 197 public institutions and $219 in the 321 private colleges and universities.

Board rates.—Average board rates for the academic year (based on meals served on a 7-day-week basis) in 159 public 4-year colleges and universities increased by 2 percent from 1958–59 to 1959–60 and by 4 percent from 1957–58 to 1959–60. For the same periods, the increases in comparable charges in 284 private institutions were 2.4 percent and 5.6 percent. The average 1959–60 board rate for the academic year (7-day-week basis) was $364 in the 159 public institutions and $424 in the 284 private colleges and universities.

Trends in charges for tuition and fees and room and board, as reported by the same institutions in 1957–58, 1958–59, and 1959–60, are shown in fuller detail in *Trends in Higher Education and Management Data, 1957–58 to 1959–60*, by W. Robert Bokelman and Louis A. D'Amico (OE–53010—see listing under *New Publications, Higher Education*, October–November). The publication also shows trends in faculty salaries and salaries of seven selected administrative positions for the same period.

The Three-Two Plan of Engineering Education

A COMPLETE DIRECTORY of colleges and universities participating in the three-two plan of engineering education is now available in an OE bulletin *The Three-Two Plan of Engineering Education*, by Henry H. Armsby, chief for engineering education in the Division of Higher Education. (See *New Publications.*)

The three-two plan has been developed, chiefly in recent years, as one method of providing a broader and more diversified type of education than the regular 4-year engineering program. To achieve this purpose, a number of engineering and nonengineering

colleges have made cooperative arrangements which make it possible for students to pursue undergraduate programs in both liberal arts and engineering curriculums. The usual pattern, generally called the "three-two plan," permits a student to attend a nonengineering college for 3 years and then attend a cooperating engineering college for 2 years, in both instances following a program agreed upon between the two institutions. If he completes his work satisfactorily, he receives the bachelor of arts degree from the nonengineering college at the end of his fourth year and the bachelor of science degree in engineering from the engineering college at the end of the fifth year. In some cases, the two colleges are parts of the same university.

The bulletin describes the historic development of the three-two plan and shows which institutions in each category collaborate with which institutions in the other category.

Federal Funds for Education

FEDERAL EXPENDITURES in support of education—elementary, secondary, higher, and adult education—amounted to $2.4 billion in 1958–59, according to information furnished the Office of Education by Federal agencies that either conduct educational programs or give financial assistance to programs conducted by others.

This total is from the current and 15th edition of a series of Office of Education reports begun 25 years ago. *Federal Funds for Education, 1958–59 and 1959–60*, by Clayton D. Hutchins, Albert R. Munse, and Edna D. Booher (see "New Publications"), is an authoritative and comprehensive source of information on Federal support of education. It shows the amounts expended by individual States in the 1958–59 school year and, where available, in 1959–60. It also includes summary tables that report program amounts over a 10-year period. In addition to compilations of dollar amounts expended for educational programs, the bulletin identifies authorizing acts of Congress, describes the individual programs, and discusses the methods used in apportioning the funds.

Separate chapters are devoted to funds expended for educational activities by each of the departments of the Federal Government. The concluding chapter reports those expended by 13 independent Federal agencies such as the Atomic Energy Commission, the Federal Aviation Industry, and the National Science Foundation.

The report is a compilation of information provided by Federal departments, agencies, and offices, all of which were invited by the Office of Education to participate and to report on programs which fell under one of these categories:

1. Programs of Federal assistance given in the form of commodities, funds, or services to educational institutions, including Federal, State, and local or private educational agencies.

2. Programs of research and training conducted in educational institutions including research centers operated by them and hospitals.

3. Programs for the training of non-Federal research workers and technicians in Federal institutions.

4. Programs in which a pupil-teacher relationship exists for which a Federal department, agency, or office provides instruction, lectures, tuition, contracts for educational services, school housing, or expenses required by students engaged in educational activities under Federal sponsorship.

Interinstitutional Cooperation

THE EXPANDING CONCEPT of interinstitutional cooperation in higher education in the United States is reviewed in depth in a recently released Office of Education publication, *Cooperative Projects Among Colleges and Universities*, by S. V. Martorana, James C. Messersmith, and Lawrence O. Nelson (see "New Publications"). Although the concept of interinstitutional cooperation in higher education is not new, it has only recently come to be widely acknowledged, publicized, and discussed. Published statements of such cooperative arrangements have dwelt primarily on their scope, procedures, and outcomes. There is a definite need today for a more systematic, regular, and detailed reporting of such programs in terms of type, scope, planning, administration, evaluation, and financing.

This publication discusses the character of cooperative arrangements, their scope of operation, administrative procedures, provisions for evaluation, favorable and unfavorable factors, and related considerations. It describes 29 selected cooperative arrangements—24 State and local area programs and 5 interstate regional programs. In addition, in illus-

tration of the significance of planning aspects to the effective establishment of cooperative programs, it offers as a case study the deliberations of the Washington, D.C., Conference on Interinstitutional Cooperation.

The publication cites 5 reasons frequently given for considering cooperative arrangements:

1. More effective utilization of resources, both physical and human.
2. Program enrichment in the way of broadened offerings and a more stable selection.
3. Economy of operation by reducing faculty, plant, and fund needs to an operational level consistent with sound administration.
4. Improved community service through the selection of competence areas by cooperating institutions and through reduced duplication of offerings.
5. Institutional stimulation embracing students, faculty, administration, and staff.

The 29 cooperative arrangements described in the report include the exchange or joint use of personnel, physical facilities, academic programs, and administrative relationships. Some of the programs represent agreements between two higher education institutions or between one such institution and another community agency or enterprise; in other instances, the cooperating institutions have numbered as many as 30. Some programs were established nearly 2 decades ago, while others are of relatively recent origin, such as the Harrisburg Area Center for Higher Education, the Associated Colleges of the Midwest, and the Committee on Institutional Cooperation ("Big Ten" Institutions and the University of Chicago).

The publication concludes with a statement of principles and guidelines for establishing interinstitutional programs. It stresses the need for increased interinstitutional cooperation in higher education, recognizing that the growth and development of such programs rests in the hands of leaders in the field of higher education.

National Defense Education Act Notes

Proposals for Support of Language and Area Centers

NEGOTIATIONS are now under way for the renewal of contracts in 1962–63 for the 47 language and area centers being supported this year and for 5 new Latin American centers.

A total of $2,080,000 has been allotted to the centers program in fiscal year 1962, an increase of $329,000 over the last fiscal year. Of this amount, $200,000 will be used to support the Latin American centers, and the remainder will be used to continue support at the present levels of most of the 47 centers and to expand the centers program in exceptionally critical areas. It has been announced that this expansion will take place in the following:

(1) present centers dealing with Southeast Asia and sub-Saharan Africa which may wish to expand academic year activities;
(2) present centers dealing with Southeast Asia, sub-Saharan Africa, and South Asia which may wish to offer intensive language programs during the summer of 1962.

While all centers have been able to propose an intensive language program for the summer of 1962 involving support above the present level of support, priority for summer support will be given to Southeast Asia, sub-Saharan Africa, and South Asia.

Title IV Advisory Committee Reviews Graduate School Proposals

THE NATIONAL DEFENSE Graduate Fellowship Advisory Committee met in Washington during the week of October 29 to review 1,120 proposals for new and expanded graduate programs submitted by 173 colleges and universities. The proposals included requests for 5,621 fellowships.

The 12-member advisory committee was assisted in its review by a panel of 11 consultants, representing various academic disciplines. The committee and panel recommendations for approval of programs have been submitted to the Commissioner of Education, who will announce the programs approved and the number of fellowships allocated to each on or about December 5. Graduate students interested in fellowships may then apply directly to the graduate schools with approved programs.

In reviewing the proposals, the committee and panel were governed by new guidelines recently adopted by the Office of Education as the result of a stipulation in the fiscal year 1962 appropriation bill

for NDEA that Title IV funds should be used only to support programs that are "found by the Commissioner of Education to be consistent with the purposes of the Act as stated in Section 101 thereof." This section sets forth the general purposes of the act.

In outlining for the advisory committee the revised criteria for approving programs, Harold Howe, Chief of the Graduate Fellowship Program, stated that congressional criticism has not implied that the purposes of Title IV could or should be served by a narrow selection of programs for approval. It is clear, Dr. Howe said, that the Congress would have us continue to support graduate programs in the humanities and social sciences as well as in the sciences, mathematics, engineering, and modern foreign languages but that the Congress views the basic objectives of Title IV as the preparation of additional numbers of well-trained persons to teach *the basic disciplines* at the undergraduate level, which is to say those fields most commonly studied by undergraduates. Consequently, "it is more difficult to justify support for undergraduate fields of study pursued by relatively few students unless it can be shown that they are directly related to the national defense."

The fields of study announced as eligible for priority consideration under Title IV are as follows: Agriculture, American studies, anthropology, biological sciences, economics, education, engineering, English, foreign area studies, geography, history, mathematics, modern foreign languages and linguistics, philosophy, physical sciences, political science (including international relations), psychology, sociology.

Among the fields of study excluded from priority consideration are the fine and applied arts, ancient studies, and religion. Moreover, within the general area of the social sciences, Dr. Howe pointed out, "lesser priorities in some instances will have to be given to those of an applied nature than to those that serve as basic foundations for undergraduate training."

Other Developments in NDEA in Higher Education Programs

Other developments within the four NDEA higher education programs are these:

▸ Arrangements were completed for the allocation of $400,000 in student loan funds for Cuban nationals enrolled in U.S. institutions of higher education. About 1,500 Cuban students attending 143 colleges and universities are expected to make loans in the first semester. The funds have been made available through the contingency fund of the Mutual Security Act. No decision has yet been made as to financing the loan fund during the second semester.

▸ Twelve consultants reviewed 125 proposals for modern foreign language institutes in the summer of 1962 and during the 1962–63 academic year. About 75 summer institutes and 7 regular-session institutes will be conducted for about 4,000 elementary and secondary language teachers. Names of the institutes will be announced December 26.

▸ Eighteen counselor educators from institutions of higher education reviewed and rated 117 proposals submitted by colleges and universities for counseling and guidance training institutes in the summer of 1962. Both the summer institutes and the 1962–63 regular session institutes will be announced in December.

▸ Application kits were distributed for students interested in Modern Foreign Language Fellowships in 1962–63. About 1,100 such awards will be made, about half of them to students who already have fellowships. For the first time, students of Latin American Spanish and area studies will be eligible. Fellowships are not available for students of French, German, or Italian. Students apply directly to the graduate school they plan to attend.

▸ Funds totaling $1,551,837 are being allocated to 391 colleges and universities with particularly pressing student demands for National Defense Student Loans. The funds became available when 21 institutions returned their loan allocations for 1961–62 after Congress failed during the last session to repeal the disclaimer affidavit requirement and 2 institutions decided not to participate for other reasons. The 391 institutions applied for a total of $5,263,142. Their applications were reviewed and their requests adjusted according to the funds available.

▸ Support totaling $100,000 is being given to five universities for strengthening instruction at Latin American language and area centers during the second semester of the current academic year and the summer of 1962: Columbia University, Tulane University, University of California (Los Angeles), University of Florida, and University of Texas. The centers, authorized by title VI of NDEA, are part of the recently instituted Latin American Studies Program organized by the Office of Education.

Other Program Notes

Capital R&D Expenditures in Colleges and Universities

DURING 1958, 253 colleges and universities in the United States spent approximately $154 million for facilities and other capital items needed for research and development in the natural and social sciences. Nearly $111 million of the expenditures were made in the colleges and universities proper—exclusive of agricultural experiment stations and Federal-contract research centers administered by the colleges and universities. The 1958 capital expenditures made by each of these three organizational units and their sources of support are shown below.

(In thousands)

Organizational unit	*Total capital expenditures*	*Source of support*	
		Federal	*Other*
Total	$153,539	$41,361	$112,178
Colleges and universities proper	110,688	14,715	95,973
Engineering schools	19,896	1,268	18,628
Medical schools	42,371	7,207	35,164
Other units	48,421	6,240	42,181
Agricultural experiment stations including schools of agriculture	15,454	411	15,043
Federal-contract research centers	27,397	26,235	1,162

Non-Federal sources—college and university funds, State appropriations, private endowments, and other private sources—contributed approximately three-fourths (over $112 million) of the total and the Federal Government contributed the remainder (over $41 million). The Federal contributions are shown below by agency and amount:

	(In thousands)
Atomic Energy Commission	$29,561
Department of Defense	614
Department of Health, Education, and Welfare	9,855
National Science Foundation	580
Other agencies	751
Total Federal Government	41,361

The Atomic Energy Commission, with contributions of almost $30 million, was the major agency source of the Federal funds.

Twelve colleges and universities spent more than one-half of the total investment in R&D facilities and capital items made by the 253 institutions, and about one-third of the reporting institutions each spent less than $10,000. The distribution of R&D capital expenditures in the 253 colleges and universities during 1958 is shown below by expenditure class.

R&D expenditure class	Number of institutions	Total R&D capital outlays
	(Dollar amounts in thousands)	
Total	253	$153,539
Under $10	80	243
$10–$69	53	1,286
$70–$199	40	4,729
$200–$499	27	8,438
$500–$999	14	10,072
$1,000–$2,999	27	45,049
$3,000 and over	12	83,362

By field of science, total expenditures were distributed as follows: life sciences, 50 percent; physical sciences, 33 percent; engineering, 15 percent; and social sciences, 3 percent. The large percentage in the life sciences reflects expenditures for costly medical-school facilities.

Almost three-fourths of the 1958 total funds for operating expenditures for separately budgeted research and development in the colleges and universities came from Federal sources in contrast to one-fourth of the total support for research and development facilities. Expenditures for R&D facilities were equal to about one-fifth of the total current operating expenditures of the colleges and universities for separately budgeted research and development during that year.

These and other facts on 1958 capital expenditures for research and development in colleges and universities were revealed in a survey conducted by the Office of Education for the National Science Foundation. They are reported in *Reviews of Data on Research and Development, No. 28.* (See "New Publications.") A summary of the operating expenditure phase of the study appeared in *Higher Education* for May 1960.

(*From page 6*)

must begin at the secondary school level, where AEC makes special effort to attract the attention and develop the interest of students in the facts and significance of radioisotopes and radiation in the physical and life sciences;

(2) to diffuse nuclear technology and an appreciation of its potentialities throughout all pertinent college and graduate curriculums, including industrial applications, engineering, physical sciences, radiation biology and medicine, and other health-related activities;

(3) to assist in informing the general public to the extent that it may understand and respect the new dicipline of atomic energy—again with emphasis on the secondary school level as the source from which information most readily diffuses into the home.

As an addendum to this article, there is outlined briefly the programs of direct educational assistance to the academic community which are supported by the AEC, since there may be institutions which would yet wish to avail themselves of these opportunities. It will be noted that these programs begin at the secondary school level, where an important influence is exerted on "higher education." I would emphasize the close interrelationships between these various subdivisions: faculty training carries new interest and enthusiasm to the students and generates new courses and needs for special equipment; these in turn stimulate new enthusiasms and decisions among both faculty and students to do advanced study in the nuclear and radiation sciences; advanced study is assisted by better equipment, fellowships, research projects, and research assistantships.

AEC National and Major Laboratories

So far in this discussion I have touched only incidentally on the important role which the AEC national and major laboratories play in American scientific life. Restricting the discussion of them to exclude those laboratories which exist primarily for their support of production activities, we are still left with a highly formidable effort in basic research, conducted largely under the guidance of the country's great universities.

The continued support of the national and other large laboratory organizations by the AEC [7] has been thoroughly justified by the accomplishments that have flowed from these laboratories. Their successes have opened new fields to industry, and their challenging opportunities in research have stimulated mutually enriching relations with the universities. They offer even greater opportunities for strengthened relationships with the universities in the future than in the past.

The laboratories have developed a training program designed to provide trained personnel to meet future requirements of the national nuclear energy program, not neglecting commitments to the International Atomic Energy Agency in fulfillment of Commission responsibilities. Training objectives include:

(1) Providing *opportunities for undergraduate, graduate, and postgraduate study* in those scientific fields which lie within the scope of the AEC programs, utilizing facilities not available on university campuses. Each laboratory maintains close liaison with the universities in its area, so that a number of graduate students are able to study in Commission laboratories under cooperative arrangements between the laboratories and the universities;

(2) offering *university faculty members* up-to-date instruction in nuclear and radiation technology as applied to the physical and life sciences;

(3) maintaining *international schools* such as Argonne's International Institute of Nuclear Science and Engineering to offer advanced graduate and postgraduate training to scientists and engineers, largely through work in the laboratory's research and development programs; Oak Ridge's ORSORT (Oak Ridge School of Reactor Technology), which is open to alien students for specialized training in reactor design and hazards; Puerto Rico Nuclear Center, which was established primarily as a research and training center for Latin American scientists. In addition, preceptor-type research training is provided by all major Commission laboratories to alien scientists, either as employees or as guests, who may attend under the sponsorship of the International Atomic Energy Agency (IAEA), Agency for International Development (AID), or under bilateral or individual agreements.[8]

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[7] "Future Role of Atomic Energy Commission Laboratories," a report to the Joint Committee on Atomic Energy, January 12, 1960.

[8] Report to the Joint Committee on Atomic Energy, January 12, 1960.

With the possible exception of Oak Ridge National Laboratory (see below, however), the major laboratories of the AEC are operated by universities, so that in effect all AEC laboratories have very close university ties. To quote from the AEC report (5) to the congressional Joint Committee on Atomic Energy, "the links between the laboratories and the universities must be further reinforced, and additional opportunities for interplay will be sought." It may be interesting to review these efforts as follows:

1. *Argonne National Laboratory* is operated by the University of Chicago, under contract with the AEC. The growing and expanding range of ANL activities, however, involves university relationships which are facilitated by the "Associated Midwest Universities, Inc." (AMU), a non-profit group of 31 midwest universities formed to promote participation in the Argonne program by the university researchers. AMU was evolved "to establish means for facilitating the use of the Argonne National Laboratory and other laboratories by duly qualified personnel and students from the several cooperating institutions and other research and educational institutions."

In addition to AMU, the "Associated Colleges of the Midwest" (ACM) was organized in 1958 by 10 midwestern coeducational liberal arts colleges* in Minnesota, Wisconsin, Iowa, and Illinois, for the purpose of conducting with Argonne—

a. *research program for teachers*, which provides an opportunity for selected scientific faculty members of the Association to spend about 15 months in a stimulating research atmosphere, with superb research equipment and a long enough period of time to make significant progress on research problems in which they are interested;

b. *semester program for students*, which enables advanced students chosen from ACM in biology, chemistry, and physics to spend a semester at Argonne as part-time research assistants to ANL scientists and to pursue their studies under the tutelage of the participants in the faculty program described in (a) above. This program gives promising prospective scientists an introduction to research in action in the fields of nuclear science.

2. *Brookhaven National Laboratory* is operated by "Associated Universities, Inc.," a corporation composed of nine northeast universities* under contract with AEC. Cooperative educational and research programs are conducted between AUI and Brookhaven, somewhat as between AMU and Argonne, whereby both faculty and students from the universities are enabled to conduct their research in the unique facilities of Brookhaven. The Brookhaven program is characterized by emphasis on basic research and by large scale participation of scientists and engineers from other institutions. Some 300 such participating visitors average about a third of their time at the laboratory. Additionally, about 60 foreign nationals are normally in residence on temporary appointments as research associates or visiting scientists.

3. *Oak Ridge National Laboratory and Oak Ridge Institute of Nuclear Studies.* Oak Ridge National Laboratory is operated for AEC by the Union Carbide Nuclear Corporation, the one industrial contractor who operates a major research installation. There is, however, close cooperation between ORNL and the Oak Ridge Institute of Nuclear Studies (ORINS) in many areas of education and training. ORINS is a nonprofit educational corporation operated by 38 universities and colleges in the South and Southeast, for the purpose of encouraging the advancement of knowledge in nuclear science and technology and related fields. It conducts biological and medical research, and training in radioisotope techniques in its own facilities on the Oak Ridge site. It also administers programs of research and lecture participation between member universities and ORNL/ORINS. The Oak Ridge Graduate Fellowship Program provides to qualified graduate students in science, mathematics, and engineering the opportunity to use the Oak Ridge AEC facilities for thesis research. The Oak Ridge Research Participation Plan enables selected university faculty members to participate in pure or applied research in Oak Ridge facilities

4. *Los Alamos Scientific Laboratory* (New Mexico) and the *E. O. Lawrence Radiation Laboratory* (Berkeley and Livermore, Calif.) are operated for AEC

*Beloit, Carleton, Coe, Cornell (Mt. Vernon, Iowa), Grinnell, Knox, Lawrence, Monmouth, Ripon, St. Olaf.

*Columbia, Cornell, Harvard, Johns-Hopkins, Massachusetts Institute of Technology, Princeton, Pennsylvania, Rochester, Yale.

by the University of California. Both have strong university participation programs in unclassified areas of research. The Los Alamos program includes important researches in the fields of nuclear weapons, thermonuclear reactions and advanced fission reactors, including their application to rocket proplusion. The Radiation Laboratory at Berkeley was in existence before the Atomic Energy Commission assumed sponsorship. The basic research program is conducted by faculty members on a part-time basis, by full-time nonacademic personnel, and by some 250 graduate students who do their thesis research in the laboratory. At the Livermore site of the Lawrence Laboratory, basic research and development is conducted on nuclear weapons, on systems for nuclear propulsion, and on controlled thermonuclear reactions.

5. *Ames Institute for Atomic Research*, operated for AEC by Iowa State University at Ames, Iowa, for studies in metallurgy and chemistry, has a research staff of persons who spend part time in academic pursuits, ranging from senior professors to graduate students. There is a close interrelation with academic research, with the result that some 500 advanced degrees have been granted by Iowa State on the basis, in part, of work done at the Ames Laboratory.

6. *Major University On-Campus Laboratories* are represented by the following examples. Some of these laboratories are distinguished by the fact that they have programs limited to a specific field of work. Others are "laboratories" in the sense that they conduct related work carried on under several separate contracts.

Argonne Cancer Research Hospital (University of Chicago)
Columbia University Nuclear Physics and Radiochemistry Research Laboratories
M.I.T. Laboratory for Nuclear Studies (including the Cambridge Electron Accelerator)
Notre Dame Radiation Laboratory
Princeton-Pennsylvania Proton Accelerator Laboratory
Princeton Stellarator Laboratory
Stanford Linear Accelerator Laboratory
University of California (LA) Biomedical Project
University of Chicago Nuclear Chemistry Research Laboratory
University of Rochester Biomedical Project

All are research-oriented so as to provide opportunities for both faculty and graduate students in basic and applied research.

Summary

The national community must accept a major share of the responsibility for supporting, strengthening, and expanding basic research and graduate education in *all* intellectual pursuits. The record shows that the Atomic Energy Commission, as an integral part of the national community, has been intimately associated with higher scientific education in U.S. colleges and universities ever since its inception, through the early support of graduate and post-doctoral fellowships and the continued support of large amounts of basic research in the physical and life sciences. This support has helped to provide an atmosphere of *live learning*, in which graduate education and basic research thrive symbiotically. Or for those who prefer a more physically oriented figure of speech, academic research is like a breeder reactor (a simile attributed to Nathaniel H. Frank, professor at MIT) which generates the heat and power of new knowledge, at the same time developing a new generation of scientists who will in turn—etc. The Nation needs both the new knowledge and the new scientists if the AEC is to continue to carry out the mission assigned to it by its congressional charter, to produce "an ever expanding fund of theoretical and practical knowledge." In addition to the direct support of basic research in academic laboratories, AEC supports its own national and major laboratories which, however, are largely administered for AEC by U.S. universities and have strong academic ties. AEC also gives *direct* assistance to schools, faculty, and students in terms of nuclear equipment and teaching aids, and training via institutes, specialized fellowships and research assistantships. Its efforts begin at the high school level on the basis that stimulation of interest in gifted high school students will encourage more of them to go on for higher education in the nuclear and radiation aspects of physical and life sciences. AEC fellowships for this purpose at the graduate and post-doctoral levels have unfortunately been lacking during the past decade, but some restoration is to be encouraged. The Atomic Energy Commission has every intention of continuing and strengthening its educational efforts and academic connections at all levels, and by every practical means, from the levels of secondary education to those of higher education.

Addendum—Summary of AEC Educational Assistance Programs

Following is a summary of the educational assistance programs which are presently being conducted under the auspices of the AEC or its contractors. Further information is available from the administrative contractor (if named) or from the Atomic Energy Commission, Washington 25, D.C.

INSTITUTIONAL ASSISTANCE

AEC equipment grants and loans.—Financial assistance is granted to colleges and universities (including engineering, graduate, medical, and related schools) for the purchase of materials, apparatus and nuclear equipment for educational purposes. The intent is to enable schools to up-date existing courses and to introduce new courses in appropriate nuclear and radiation technology as these relate to the physical sciences, radiation biology, engineering, and industrial radioisotope applications. AEC lends without charge to nonprofit educational institutions such source materials, special nuclear, byproduct, and other materials as are peculiarly related to nuclear reactor technology and the teaching of biological and medical effects; it also provides funds and services for fabrication and processing of fuel for research reactor facilities.

Lecture series.—Scientists actively engaged in research in nuclear and radiation aspects of the physical and life sciences at universities and AEC laboratories are enabled to visit high schools and colleges and universities to lecture on their teaching and/or research programs. They also confer with students and faculty concerning possible careers, courses of study, etc. Such lectures are sponsored by AEC through Oak Ridge Institute of Nuclear Studies (ORINS) and American Institute of Biological Sciences. A somewhat similar program of seminar speakers is administered for Argonne National Laboratory by Associated Midwest Universities. All AEC laboratories encourage their staff members to lecture on appropriate subjects.

Traveling teachers program.—This program, administered by ORINS, provides selected high school teachers with special training and mobile equipment, for visiting high school science classes during the school year, for one or two weeks per school.

Teaching aids.—These include laboratory manuals, some with special instructional notes; demonstration and lecture films on specialized subjects; laboratory "mockups" and working models to demonstrate devices and principles pertaining to isotope technology.

Exhibits.—Oak Ridge Institute of Nuclear Studies maintains the American Museum of Atomic Energy at Oak Ridge, Tenn. It also makes the following exhibits available to schools and organizations: "This Atomic World, a high-school lecture demonstration with speaker; "You and the Atom" and "Your Stake in the Atom," exhibits with demonstrators for fairs, community centers, etc.; "Atoms at Work," a mobile walk-through exhibit; and "Atoms in Action," an unmanned panel exhibit. New exhibits are continually under development.

FACULTY ASSISTANCE

Institutes.—"Institutes" for high school and college faculty members are sponsored by AEC cooperatively with the National Science Foundation, and to a more limited extent with the American Society for Engineering Education. For the most part, these institutes are conducted on university campuses for 6 to 8 weeks each summer in radiation biology, nuclear physics and engineering, and isotope technology. Three to seven "in-service" institutes in radiation biology are held each year for high school teachers who attend classes weekly during the school year. A new "academic year" institute program in radiation biology was begun this year for college teachers on leave for full-time graduate study. A total of 40 of these institutes were held in 1961; the number will increase somewhat during the next few years.

Seminars.—More than a hundred seminars and workshops have been held to orient high school and college teachers to the peacetime uses of atomic energy, at a level somewhat below that of a strictly scientific symposium. More than a dozen per year are held over the country in cooperation with State departments of education, professional educational associations, and schools of education.

Isotope technique and mobile training courses.—A basic 2-week course in the techniques of radioisotope use is presented seven times yearly by the Oak Ridge Institute of Nuclear Studies. Each is followed by a second and third 2-week session devoted more specifically to applications. These preparatory courses are popular with university and college faculty members. A mobile isotope laboratory brings training in radioisotope techniques to small colleges which cannot spare faculty for off-campus training during the academic year.

Research opportunities in AEC laboratories.—All of the AEC laboratories offer opportunities for college and university faculty members to conduct research in their facilities under more or less formally organized programs. The Oak Ridge Research Participation Program, for example, administered through ORINS, enables faculty members to propose research which they would conduct in one of the laboratories of the Oak Ridge complex, for periods ranging from the summer months to a full year, at pay equivalent to their academic salaries. They must return to their prior positions. At Argonne National Laboratory arrangements have been made for associated university faculty members to use the great new high-energy synchrotron now being constructed there. Approximately half of the research time of the accelerator will be available for university use.

STUDENT ASSISTANCE

Fellowships.—Although the AEC operated a broad program of science fellowships in its early years, these were for the most part taken over by the National Institutes of Health and by the National Science Foundation upon its formation. The specialized fellowship programs now oper-

STUDENT ASSISTANCE—Continued

ated by the Commission are all in the postgraduate area, are unique to the needs of the Commission, and are not duplicated by any other agency. The presently existing fellowships are in:

Nuclear science and engineering, to encourage promising scientific and engineering students to pursue graduate work in nuclear science and engineering, leading to the master's and doctor's degrees.

Health physics, to train college graduates from science and engineering courses for the profession of health physics in its many aspects of physics, biophysics, and principles of radiation protection, leading to the master's and doctor's degrees.

Industrial hygiene, to train college graduates in science and engineering for the control and/or elimination of toxic substances in the working environment. These fellowships lead to the master's degree.

Industrial medicine, to give 2–3 years of additional instruction, academic and practical, to M.D.'s for the practice of occupational medicine.

Temporary employment and junior trainee programs.—Summer employment as research assistants is offered to a limited number of college science students by practically all of the AEC laboratories, with preference to those who plan to go on to graduate school. Employment and trainee programs build up a background of laboratory training, while attendance at lectures and seminars is often required of the student employees.

Research assistants and associates.—Although AEC does not offer fellowships (other than the specialized ones described above) to graduate students, it strongly encourages the employment of graduate students as part-time research assistants on its university research projects. Many hundreds of students are so employed. Arrangements are also made by several of the AEC laboratories for graduate students to do their thesis research in these laboratories on subjects of special interest to the laboratories. The Lawrence Radiation Laboratory at Berkeley offers its facilities to some 250 graduate students who do their thesis research there, in large part as paid research assistants—possibly the largest number of students accommodated in any of the AEC-supported installations. The Argonne National Laboratory, the Brookhaven Laboratory, the Oak Ridge National Laboratory, and the Ames Institute for Atomic Research, as well as many AEC-supported on-campus laboratories, have arrangements for graduate-student participation, in many cases as paid research assistants. Argonne National Laboratory encourages midwest universities to make use of the unique facilities of its International Institute by bringing their students in nuclear science and engineering for short visits to perform experiments on equipment not available in their own institutions, such as various research reactors and simulators, analog computers, exponential assemblies, and metallurgical facilities.

Another important link with colleges and universities is an arrangement whereby graduates who have received their doctoral degree and who have shown outstanding ability in fundamental research are given limited appointments as postdoctoral research associates in the national laboratories.

Summer institutes for high school and college students.—Summer institutes, of the general nature of those described above as assistance to faculty, are planned for the near future to give special attention to science majors in high schools and colleges, possibly with emphasis on students in teachers' colleges who, as prospective science teachers, can be reached *before* remedial training is required. These institutes will of course stress nuclear and radiation aspects of the physical and life sciences.

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(*1*) *Cost Publications: Send request, enclosing remittance (check or money order), to the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.*

(*2*) *Free Publications: Request direct from the Agency issuing them.*

From the Office of Education

Cooperative Projects Among Colleges and Universities, by S. V. Martorana, James C. Messersmith, and Lawrence O. Nelson. Washington, U.S. Government Printing Office, 1961. 45 p. 35 cents. (OE–50020.) See page 15.

The Credit System, *New Dimensions in Higher Education*, No. 9, by Lanora G. Lewis. Washington, U.S. Government Printing Office, 1961. 37 p. 20 cents. (OE–50021.) See page 11.

Federal Funds for Education, 1958–59 and 1959–60, by Clayton D. Hutchins, Albert R. Munse, and Edna D. Booher. Washington, U.S. Government Printing Office, 1961. 247 p. $1. (OE–10009.) See page 15.

Graduate Education, An Annotated Bibliography, by James H. Blessing. Washington, U.S. Government Printing Office, 1961. 151 p. 60 cents. (OE–50022.)

Opening (Fall) Enrollment in Higher Education, 1960: Analytic Report, by Edith M. Huddleston. Washington, U.S. Government Printing Office, 1961. 43 p. 35 cents. (Circular No. 652, OE–54007–60.)

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1961: Institutional Data, by Educational Statistics Branch, Division of Statistics and Research Services, Office of Education. Washington, U.S. Government Printing Office, 1961. 35 p. 25 cents. (Circular No. 675, OE–54003–61.) See page 11.

Summary Report on Survey of Students Enrolled for Advanced Degrees: Fall 1960, by Wayne E. Tolliver. Washington, U.S. Department of Health, Education, and Welfare, Office of Education, September 1961. 7 p. (OE–54009–60.)

The Three-Two Plan of Engineering Education, by Henry H. Armsby. Washington, U.S. Government Printing Office, 1961. 32 p. 20 cents. (OE–56005.) See page 14.

From Other Government Agencies

Health, Education, and Welfare Trends, 1961 Edition. Washington, U.S. Government Printing Office. 136 p. $1. Illus.

Charts and tables on more than 100 subjects present data for several past decades and selected projections to the 1970's. Part I presents national data on a wide range of subjects, such as population, vital statistics, health conditions, education, consumer interests, social security, welfare, and government finances. Part II presents selected data at the State level.

HEW Trends is an annual supplement to the monthly publication *HEW Indicators*.

Reviews of Data on Research and Development, No. 28, "Capital Expenditures for Research and Development in Colleges and Universities, Fiscal Year 1958." Washington, U.S. Government Printing Office, June 1961. 4 p. 5 cents. (National Science Foundation, NSF 61–31.)

Summarized in this issue.

Reviews of Data on Research and Development, No. 29, "Scientists and Engineers in Research and Development, 1958," Washington, U.S. Government Printing Office, August 1961. 6 p. 10 cents. (National Science Foundation, NSF 61–49.)

Presents statistics derived from NSF survey program which covers expenditures and personnel employed in research and development in the four sectors of the economy—Federal Government, industry, colleges and universities, and other nonprofit institutions.

Scientists and Engineers in the Federal Government, October 1958. Washington, U.S. Government Printing Office, 1961. 44 p. 35 cents. (National Science Foundation, NSF 61–43.)

Deals mainly with the fields of employment of scientific and technical personnel in Federal agencies. Also shows the number of those persons engaged in research and development and presents data on trends since 1954.

Non-Government Publications

Work-Study College Programs—Appraisal and Report of the Study of Cooperative Education, by James W. Wilson and Edward H. Lyons. New York, Harper and Brothers, 1961. 240 p. $3.50.

This book is based on the findings and recommendations of an 18-month study of representative programs in which students combine study with off-campus work. The study was under the auspices of the Thomas Alva Edison Foundation, and was directed by Ralph W. Tyler.

The definition of cooperative education used in this study omits the requirements generally included in previous studies that work experience be definitely related to the student's field of study, and that it become progressively more difficult.

Sixty-one institutions granting baccalaureate degrees were found to fit this more inclusive definition. Seventeen of the institutions with cooperative programs and ten without were selected for study and appraisal.

The appraisal includes consideration of the extent to which claims about cooperative education made in previous studies are justified. These claims concern educational consequenses and values for the student, the institution, the cooperating industries and agencies, and for society.

The report also contains much new material on the characteristics of cooperative students, and statistical analyses of the large amount of data on this and other phases of the cooperative program, which should be of interest to college officials, especially those considering the establishment of such programs.

The judgments of the committee in charge, based on the findings of the staff, are summarized as follows: "Cooperative education has important values for colleges and universities, for students and employers. These values should be given wide publicity and cooperative programs in American higher education should be greatly extended."

U.S. GOVERNMENT PRINTING OFFICE: 1962